Journal of Education and Learning Technology (JELT)
ISSN 2720-7730 Volume 7 Issue 2 2026, 351 - 361
Available online at: https://noyam.org/journals/jelt/
DOI: https://doi.org/10.38159/jelt.20267223

Enhancing assessment integrity in LMS-Based evaluations: Implementing the Lockdown Browser at the Central University of Technology

Ntombizanele Maqache[1]

[1] Department of Electrical, Electronic and Computer Engineering, Central University of Technology, Bloemfontein, South Africa.

ABSTRACT

The use of Learner Management Systems (LMSs) in higher education is a widely accepted approach to addressing some of the challenges faced by institutions of higher learning. LMSs facilitate student and assessment management while providing a variety of useful reports that can influence teaching and learning. However, administering assessments through LMSs in the age of Generative AI (GenAI) presents challenges different from traditional assessment methods, such as students exiting the assessment window to outsource the assessment task to AI or unauthorized collaboration through messaging applications. This paper uses a descriptive case study approach and presents how the Lockdown Browser application has been implemented at the Central University of Technology (CUT) to mitigate the risks associated with LMS-based assessments, open-book assessments in particular. The application enhanced assessment integrity by limiting unauthorized collaboration, access to external websites, and GenAI tools. The results show that, after the implementation, 0.45% or less of students reported not being able to access permitted e-resources due to authentication-related issues. The option to include acceptable e-resources in an assessment in the controlled application environment allows students the opportunity to engage with knowledge and receive validation. The implementation of the Lockdown Browser application in LMS-administered assessments has improved the credibility of open-book assessments for students in Electrical Engineering at CUT, South Africa. This also led to fewer invigilators being required to monitor students' activity on their computer screens during assessments.

Keywords: LMS-based assessments, Computer-based Assessments, Assessment integrity, AI in assessments.

INTRODUCTION

Learner Management Systems (LMS) are widely used in institutions of higher education all over the world. Even though LMSs were used pre-COVID, their importance was made more prominent during the pandemic. They became more crucial to the process of delivering education during unfavourable times. Since then, ways to make more efficient use of these systems have been highly investigated by scholars. Computer-based assessments (CBA) have been proven to yield authentic and effective evaluations in relation to paper-based assessments (PBA), particularly in large enrolment engineering

---

CORRESPONDENCE – Ntombizanele Maqache Email: nsolfafa@cut.ac.za
PUBLICATION HISTORY - Received : 9th September, 2025 | Accepted: 5th February, 2026 | Published: 14th April, 2026.
TO CITE THIS ARTICLE –Maqache, Ntombizanele. "Enhancing assessment integrity in LMS-Based evaluations: Implementing the Lockdown Browser at the Central University of Technology." *Journal of Education and Learning Technology* 7, no.2 (2026): 351 -361. https://doi.org/10.38159/jelt.20267223

courses. In addition, the CBA cohort received higher learning outcomes on specific technical topics than the PBA cohort.[1]

The use of technology in higher education has grown significantly over the years, more so since the COVID-19 pandemic. Technology has aided the way classrooms are run and how assessments are conducted. Administering assessments on LMS resolves several issues related to large classes and improving timely feedback.[2] There are also drawbacks that come with these types of assessments, especially in the age of Generative (GenAI). There's a risk of students browsing the internet for answers during an assessment or accessing files on the computer where they can find answers. A unique risk can also be found in administering open-book assessments on LMS, where students are allowed to consult certain materials to support the assessment process. Physically monitoring and controlling which materials students consult during an open-book assessment that is computer-based presents a challenge if not automated, requiring several staff members to be made available for invigilation. In this regard, digital monitoring can be more reliable and effective when implemented correctly.

Using too many digital monitoring types in an assessment may lead to anxiety and additional stress for students; it is therefore advised that educators use the least number of monitoring types necessary for the class size and expected student behaviour.[3] Monitoring types can include monitoring mouse movement, eye movement, web browser history, microphone, webcam as well as restricted browser modes. The Lockdown Browser is a specialized web browser that limits access to other applications, websites and features that could potentially be used dishonestly during an online or computer-based assessment. A survey conducted for an online course environment revealed that students thought that lockdown browsers in combination with being recorded would reduce the likelihood of cheating.[4]

This paper presents how the Respondus LockDown Browser (LDB) was used to implement LMS-based open-book assessments at CUT for engineering students. This implementation assisted with restricting students' access to materials they can interact with during the assessment process, mitigating the chances of cheating and requiring less staff for invigilation or human proctoring. This study is significant as it provides empirical evidence on the implementation of the LockDown Browser for undergraduate open-book quizzes within a South African university context. As higher education institutions increasingly adopt blended and online assessment models, the need to uphold academic integrity has become critical, particularly in environments where device access, connectivity constraints, and varying levels of digital literacy can influence assessment outcomes. By examining the practical use, student experiences, and challenges associated with this secure-assessment technology, the study contributes locally relevant insights that support fair and credible evaluation practices. Furthermore, the research provides insight into digital assessment security in African contexts and offers evidence-based recommendations to inform institutional policy, quality assurance processes, and the design of equitable online assessments.

LITERATURE REVIEW

A look into whether 741 undergraduate students cheat more in un-proctored online assessments than in proctored in-class assessments found that there was significant evidence of more cheating on un-proctored online assessments.[5] Added to these findings, it was implied that students discover how to cheat as they become more accustomed to taking online assessments. It is also worth mentioning that human proctoring was used in this study. The lack of academic integrity has been cited as the reason

[1] Tian Tian, Ronald F. DeMara, and Su Gao, "Efficacy and Perceptions of Assessment Digitization within a Large-enrollment Mechanical and Aerospace Engineering Course," *Computer Applications in Engineering Education* 27, no. 2 (March 3, 2019): 419–29, https://doi.org/10.1002/cae.22086.

[2] Elisha D Markus and Ntombizanele Maqache, "Advancing Students Learning Experiences in Laboratory Reporting through the Use of a Course Management System," in *Academic Conferences and Publishing Limited (July 2018)*, 2018.

[3] David G Balash et al., "Examining the Examiners: Students' Privacy and Security Perceptions of Online Proctoring Services," in *Seventeenth Symposium on Usable Privacy and Security (SOUPS 2021)*, 2021, 633–52.

[4] Peter A. Novick et al., "Maximizing Academic Integrity While Minimizing Stress in the Virtual Classroom," *Journal of Microbiology & Biology Education* 23, no. 1 (April 29, 2022), https://doi.org/10.1128/jmbe.00292-21.

[5] Richard Fendler, David Beard, and Jonathan Godbey, "A Robust Examination of Cheating on Unproctored Online Exams," *Electronic Journal of E-Learning* 22, no. 5 (May 8, 2024): 26–38, https://doi.org/10.34190/ejel.22.5.3173.

behind students scoring higher in un-proctored exams than in proctored exams by different scholars, necessitating the importance of proctoring to conduct assurance of learning and combat the devaluation of higher education.[6]

Studies suggest that a lot of effort must be put into implementing deterrent strategies that ensure the integrity of assessments in digital environments.[7] Faculty and students expressed favorable views about remote online open-book assessments as an authentic assessment with obvious concerns about gaps in academic integrity. Remote open-book online assessments have been used to guide students to deep learning and higher-order cognitive skills. Researchers also tudied the effect of access to electronic resources in summative assessment for 390 students at different levels, where part II of the exam allowed access to e-resources and part I did not.[8] The study concluded that access to e-resources in examination doesn't make a substantial difference in scores of higher-order cognitive level items. Suggesting that the cognitive level of questions and course type are the factors that contribute significantly to the change in exam scores when accessing e-resources. Student results from a remote proctored exam were compared with those from an on-site proctored exam, and it was found that the proctoring type did not influence exam outcomes and that remote proctoring allows flexibility without sacrificing academic integrity. This study also found that students experienced emotional distress because of the multiple digital monitoring types used in remote proctoring.[9]

There are many digital tools that have been used to monitor student activity during CBA, each meeting specific assessment needs. In one study, online open-book exams were administered using Moodle (LMS), where one group was not location-bound and proctored using ProctorU while the other group had to take the exam in an in-class proctor environment.[10] The researchers found that students who were not subject to proctoring scored on average 11% higher compared to those who were subject to proctoring, potentially because of cheating activity. Zoom and MS Teams have also been used for proctoring, and in some instances, the lockdown browser was used together with Zoom in online assessments.[11] Safe Exam Browser (SEB) is another lockdown browser that has been used in BYOD LMS-based assessments to limit access to unauthorized websites, applications and system functions.[12] Blackboard Learn doesn't support SEB. This meant that the LMS had to be included in the list of allowable websites and that extra measures had to be taken to ensure that only submissions generated through SEB were allowed by the LMS. This complicated the assessment process, requiring that invigilators be trained to deal with issues that could arise during the assessment. Using a browser that is compatible with the LMS of the institution might simplify the assessment process.

Before the COVID-19 pandemic, the Lockdown browser and Respondus Monitoring were used mainly in online education to combat cheating during assessments.[13] Implementing tight time restrictions on online open-book assessments played an important role in maintaining their academic integrity during the COVID-19 pandemic.[14] To date, researchers advocate for the use of some form of

---

[6] Ivry Zagury-Orly and Steven J. Durning, "Assessing Open-Book Examination in Medical Education: The Time Is Now," *Medical Teacher* 43, no. 8 (August 3, 2021): 972–73, https://doi.org/10.1080/0142159X.2020.1811214.

[7] Hui Meng Er, Pei Se Wong, and Vishna Devi Nadarajah, "Remote Online Open Book Examinations: Through the Lenses of Faculty and Students in Health Professions Programmes," *BMC Medical Education* 23, no. 1 (June 2, 2023): 397, https://doi.org/10.1186/s12909-023-04368-0.

[8] Shatha Al-Sharbatti et al., "The Effect of Access to Electronic Resources during Examination on Medical and Dental Students Scores in Summative Assessment: Quasi Experimental Study," *BMC Medical Education* 22, no. 1 (December 12, 2022): 859, https://doi.org/10.1186/s12909-022-03904-8.

[9] Vasiliki Andreou et al., "Remote versus On-Site Proctored Exam: Comparing Student Results in a Cross-Sectional Study," *BMC Medical Education* 21, no. 1 (December 20, 2021): 624, https://doi.org/10.1186/s12909-021-03068-x.

[10] Jose J. Vazquez, Eric P. Chiang, and Ignacio Sarmiento-Barbieri, "Can We Stay One Step Ahead of Cheaters? A Field Experiment in Proctoring Online Open Book Exams," *Journal of Behavioral and Experimental Economics* 90 (February 2021): 101653, https://doi.org/10.1016/j.socec.2020.101653.

[11] Syeda Sadia Fatima et al., "Online Assessment in Undergraduate Medical Education: Challenges and Solutions from a LMIC University," *Pakistan Journal of Medical Sciences* 37, no. 4 (May 6, 2021), https://doi.org/10.12669/pjms.37.4.3948.

[12] Oka Kurniawan, Norman Tiong Seng Lee, and Christopher M. Poskitt, "Securing Bring-Your-Own-Device (BYOD) Programming Exams," in *Proceedings of the 51st ACM Technical Symposium on Computer Science Education* (New York, NY, USA: ACM, 2020), 880–86, https://doi.org/10.1145/3328778.3366907.

[13] Vijay Raghavan and Xiaoni Zhang, "Effectiveness of Digital Controls in Stopping Academic Dishonesty in Remotely Administered Tests," 2017.

[14] Ivo J. M. Arnold, "Online Proctored Assessment during COVID-19: Has Cheating Increased?," *The Journal of Economic Education* 53, no. 4 (October 2, 2022): 277–95, https://doi.org/10.1080/00220485.2022.2111384; Eabhnat Ní Fhloinn and Olivia Fitzmaurice,

proctoring for online exams over no proctoring at all due to the element of cheating that comes with un-proctoring. Online un-proctored, proctored exams and in-class exams were compared by researchers, where Bring-Your-Own-Device (BYOD) was used, and the findings were that un-proctored online exams resulted in a score advantage of up to 5.2% over Zoom-proctored and in-class proctored exams.[15]

Another comparative study comparing non-proctored online tests, traditional in-class proctored, and online proctored tests found that the online proctored test grades were seven points lower when compared with in-class proctored tests.[16] The suggestion here is that the online proctored test was conducted in an uncontrolled environment with factors that could have affected the concentration of the students therefore, the in-class environment offers a more controlled environment with fewer external distractions. Other scholars refer to academic cheating as students outsourcing the assessment task and they attribute it to assessment being viewed as a hindrance to obtaining a qualification required by the job market.[17] In this body of work that interrogates assessment in the age of GenAIthe authors suggest that an effective response to GenAI necessitates understanding the objective of higher education as a transformative process targeted at building knowledge rather than just gaining a qualification. This leads to the need to view assessment as a chance to engage with disciplinary knowledge, explore understanding and receive validation. Therefore, outsourcing the assessment task to GenAI undermines the opportunity for engagement and misallocates the validation.

Open-book quizzes (OBQ) were introduced in 2023 for various Network subjects in Electrical Engineering at the Central University of Technology (CUT) that were based on the LMS to get students to engage more regularly with the material or content of the course. Student feedback in

Figure *1* was positive towards OBQs in that they motivated them to engage with the content in preparation, which was the general view of verbal feedback as well. At this stage, OBQs were administered on the LMS, relying solely on in-person invigilation. This posed a challenge because invigilators found it difficult to monitor multiple computer screens at the same time. At times, students would be caught wandering onto the internet and using GenAI tools to search for answers, even though they were allowed to consult their own study notes. This necessitated a digital way of limiting what students can access during OBQs as well as eliminating the element of suspicion on the side of the invigilators. The LDB was then implemented in 2024 as a remedy to the dishonesty encountered during the administering of in-class OBQ due to the staff struggling with monitoring the number of windows open during OBQ because students could easily minimize the quiz window and search for answers on the internet. With only one or two staff members available during the OBQ for between 20 and 70 students, physically monitoring what students got up to on their computer screens proved to be an impossible and tedious task.

"The Impact of the COVID-19 Pandemic upon Mathematics Assessment in Higher Education," *Education Sciences* 15, no. 4 (April 3, 2025): 449, https://doi.org/10.3390/educsci15040449; Curtise Kin Cheung Ng, "Evaluation of Academic Integrity of Online Open Book Assessments Implemented in an Undergraduate Medical Radiation Science Course during COVID-19 Pandemic," *Journal of Medical Imaging and Radiation Sciences* 51, no. 4 (December 2020): 610–16, https://doi.org/10.1016/j.jmir.2020.09.009.

[15] Martha Rodríguez-Villalobos, Jessica Fernandez-Garza, and Yolanda Heredia-Escorza, "Monitoring Methods and Student Performance in Distance Education Exams," *The International Journal of Information and Learning Technology* 40, no. 2 (March 17, 2023): 164–76, https://doi.org/10.1108/IJILT-04-2022-0085.

[16] Rodríguez-Villalobos, Fernandez-Garza, and Heredia-Escorza, "Monitoring Methods and Student Performance in Distance Education Exams."

[17] Margaret Blackie et al., "Interrogating Assessment in the Age of Generative AI," *African Journal of Inter/Multidisciplinary Studies* 6, no. 1 (2024): 1–11.

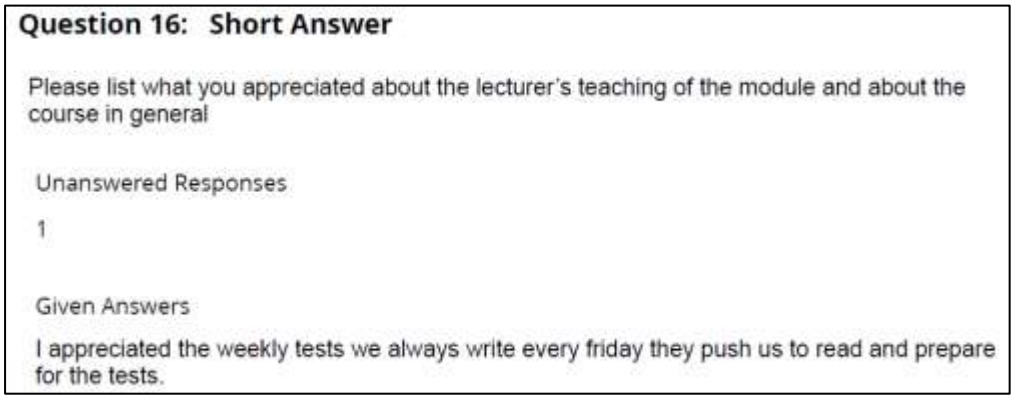

Figure 1: Student opinion about OBQ

METHODOLOGY

This article uses a descriptive case study approach to document and examine the implementation of the LDB in OBQs at CUT. The study focuses on detailing the processes, tools, and institutional context involved in deploying this technology in engineering modules delivered via the LMS. OBQs of Networks 1, 2 and 3 and Network Systems 2 were used to implement LDB in order to enhance the integrity of these continuous assessments, with a maximum of 4 OBQs per module. The class sizes varied from 20 to 70 students, where 70 is the largest capacity of the computer labs available for electrical engineering. This meant that larger classes had to be divided into repeat classes (A and B). Data was collected through observation of OBQ sessions, lecturer reflections, and informal student feedback, offering qualitative understandings into the usefulness and challenges of the intervention. No personal information was used in processing and presenting the data. The objective is not to generalize findings, but to provide a detailed explanation that may inform similar implementations in comparable educational settings.

The LDB had been widely used in the institution for prohibiting students from wandering off on their screens during closed-book assessments, and it worked quite well for keeping the students locked into the assessments. This time, it was used as a tool to limit what students can look at during OBQ. When setting up the quiz, the advanced settings of LDB, as seen in

Figure *2*, must specify the domains students would be allowed to access during the quiz to control the content they have access to through the internet on the assessment computer. When starting the quiz, a message that LDB is used appears to allow those without it to download and install it (

Figure *3*).

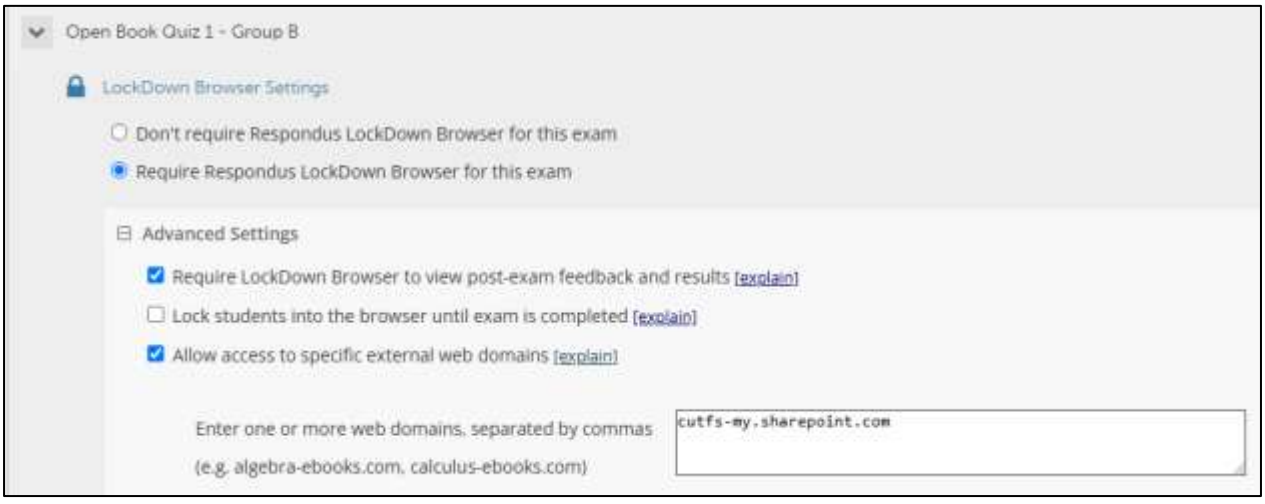

Figure 2: LDB settings in LMS

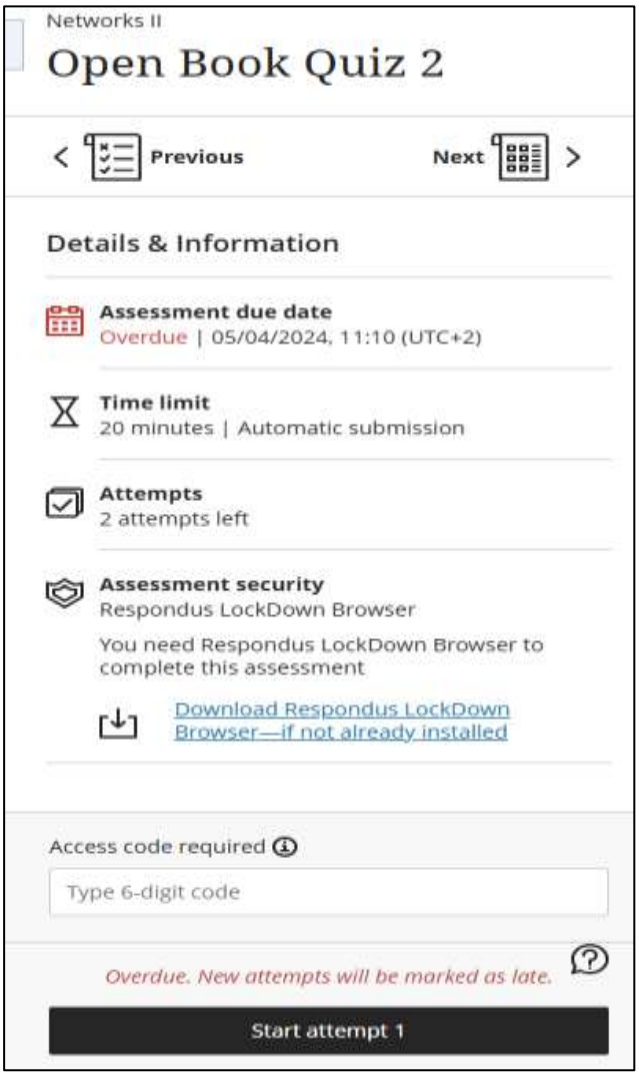

Figure 3: OBQ shows LDB is required

In this case, the PowerPoint slides were accessible on cloud storage of the institution. The clickable links to these slides, shown in Fig. 5, were then included within a quiz for students to open once the quiz is started. The students would then need to get through the authentication process to access these files. Once authenticated, the slides would open in a new tab in

Figure *4* within the assessment window. They could open as many tabs as they are allowed for the quiz if the domain is specified within the advanced settings. The students could then navigate between the tabs of reference material and the quiz (

Figure *5*) as they wished without compromising the integrity of the assessment.

A question was included with the links to establish whether students were able to successfully open the reference material within the LDB environment. The first attempt running OBQ within LDB failed to open the reference material due to file-sharing issues that were not anticipated. The files had to be stored on the lecturer's work cloud location because the computers in the labs used had deep freeze settings that would delete stored data periodically. Hence, the sharing settings must be adjusted to allow the students to access the files.

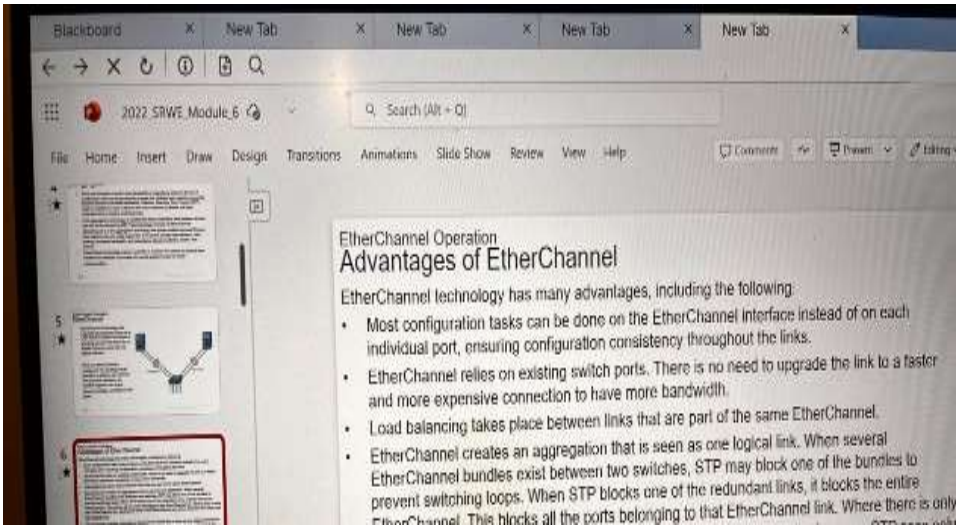

Figure 4: Different apps open as tabs in OBQ

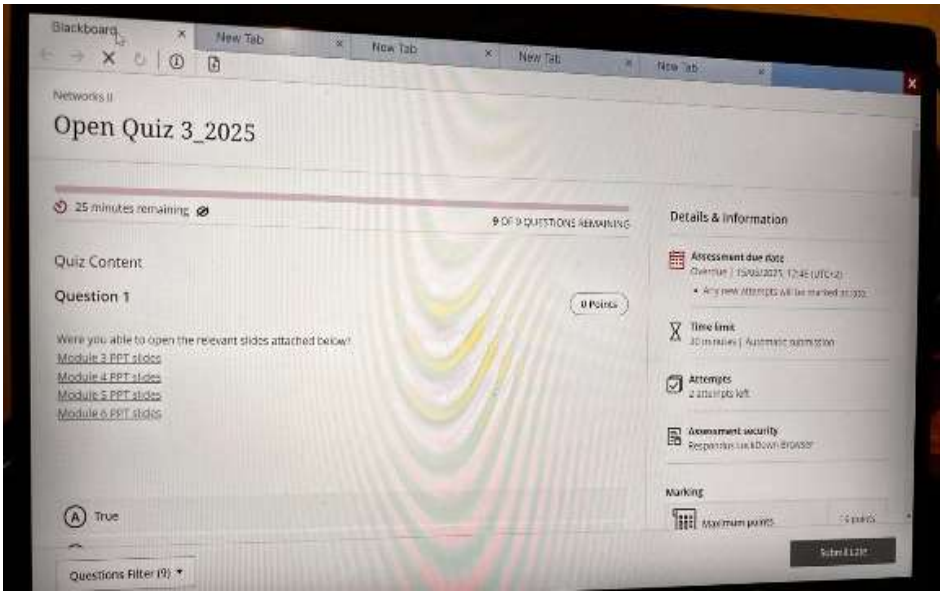

Figure 5: Navigating back to OBQ within LDB

PRESENTATION OF FINDINGS AND DISCUSSION

When all the on-site technical challenges had been resolved, students responded positively to the question in Figure 6, asking whether they were able to open the links. 22 out of 23 students responded that they were able to open the links within the OBQ as reference material. In another group in Figure 7, 70 of 71 students reported that they were able to open the links in LDB, suggesting a successful implementation of OBQ with LDB. Students were encouraged to bring their study notes in addition to the LDB reference material, which seemed to motivate prior engagement with the content. Those that answered false were due to authentication-related issues, either they forgot their student password, or second-factor authentication couldn't go through. The implementation of LDB limited unauthorized collaboration in that students could no longer access massaging applications on the computers while taking the assessment. They were also not able to browse external websites that didn't form part of allowed resources for the assessment. Furthermore, students were not able to use Gen AI tools to outsource the assessment task, contributing to enhancing the integrity of the assessment.

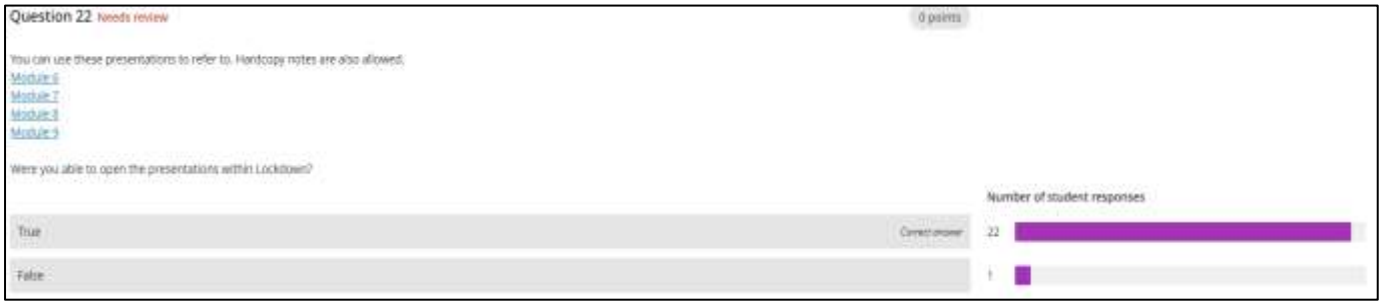

Figure 6: Quiz 2 - Networks II - 2024 - Semester 1

Figure 7: Quiz 2 - group A Network Systems II – 2024 - Semester 1

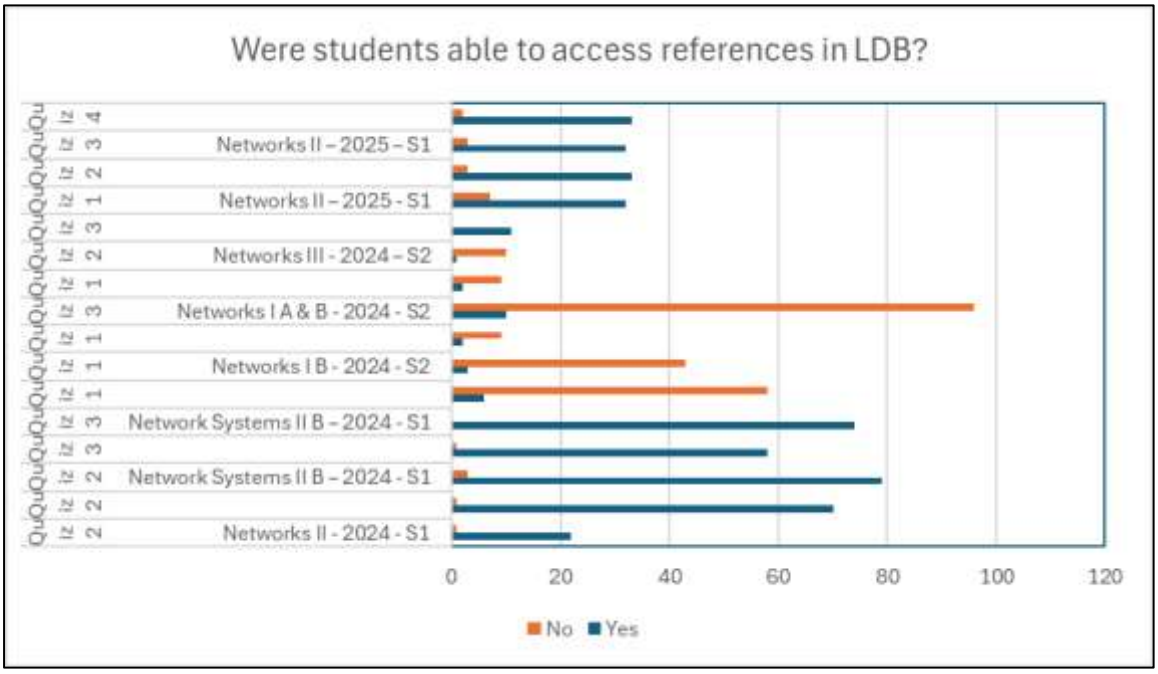

Figure 8: Number of students that were able to launch links within LDB

The use of LDB in OBQ proved to be beneficial; the invigilators did not need to physically monitor the windows open during the OBQ because students had restricted access during the quiz. The credibility of OBQ was restored by eliminating the risk of academic dishonesty incidents associated with in-person invigilation of LMS-based OBQs. **Error! Reference source not found.** shows the number of students who answered that they were able to open the links to the reference material for different OBQs in LDB. Semester 1 of 2024 reflects 0.014 to 0.45 percentage of the students reported not being successful for quiz 2 and quiz 3 of the different groups. The justification for this small number of students who answered false is that they were observed to have failed the authentication step with either a wrong password or not having the means for a second-factor authentication. South African classes often include students with varying digital literacy and unequal access to technology. This

combined with the different levels of prior exposure to online assessment systems make this implementation of LDB promote fairness in assessments for this diverse student composition.

At the beginning of the second semester of 2024, quiz 1 failed the loading of the reference material that was set up in the exact same way as those of the first semester which were successful. Students could not get through to the authentication process; they would get prompted to enter their passwords, and the screen would hang. Attempts to involve the institution's ICT did not yield any better results, as the desktop support technicians could not figure out what changed. The e-learning support of the institution could not help either. This introduced a new frustration in administering OBQ because much of the time was spent trying to resolve the issue, resulting in most of the quizzes being carried out without the multiple tabs of reference material. Students could only rely on their study notes during the quizzes as LDB was still enabled.

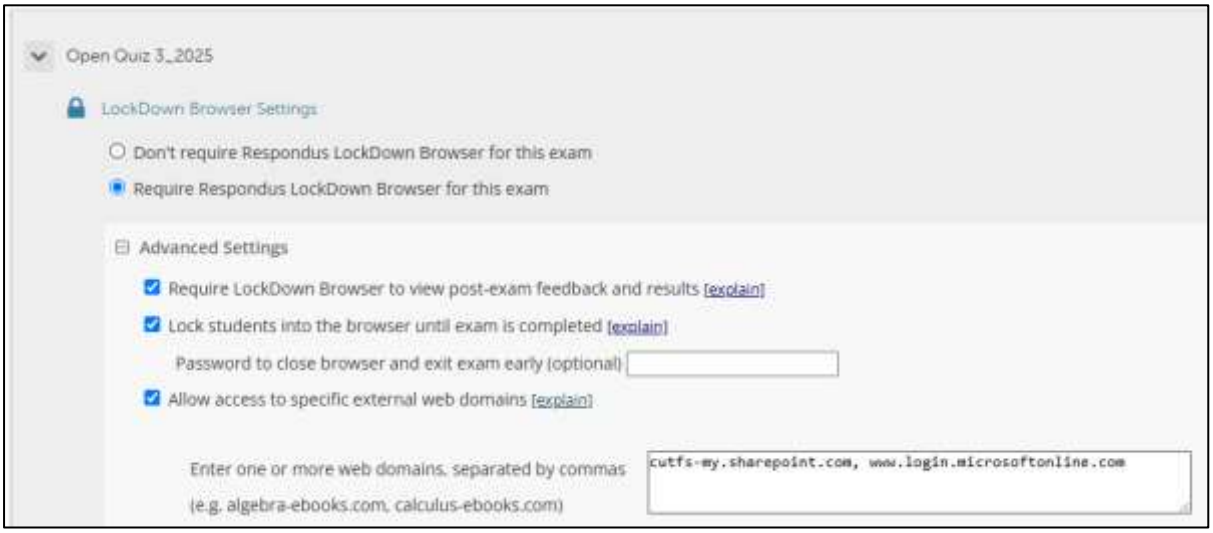

Figure 9: LDB settings after policy changes

After much research, the lecturer was able to resolve the login issue by adding another domain to the LBD settings of OBQ, as can be seen in Figure 9. After adding the required domain for the login, the students were able to authenticate and successfully open the reference material within LDB in the last OBQ of the semester. Till today, the LMS-based OBQs are still administered using LBD for Network subjects with zero technical errors. This experience provided a perspective on the institution's readiness for proctored or semi-proctored CBA and how various stakeholders have to be kept informed on ICT updates that may affect academia.

RECCOMMENDATIONS

These recommendations can be considered when implementing LDB in an institution servicing a diverse body of low-resource students. It's advised that students who have limited exposure to digital assessments can benefit from a short orientation on using LDB before actual assessments, as this could minimize anxiety. In addition, it's not all academic staff that'll have a strong technical background; it's therefore recommended that guidelines be provided to staff who implement LDB in their assessments for designing LDB-compatible OBQs. This, together with readily available ICT support for staff and students during assessments, aids in eliminating stressors that can arise from technical glitches that are unforeseen or not included in the guidelines. In the context of public institutions, it's best to administer digital OBQs in a computer lab where internet connectivity and device availability are in a controlled environment, as many students might lack these resources. It's also recommended that a small-scale pilot quiz be run before full-scale deployment in order to identify and resolve any issues that may arise without disadvantaging students. It would also be useful to gather student feedback during these pilots to further refine implementation. It's further recommended that any changes to ICT policies or infrastructure within institutions of higher education be disseminated more effectively to end-users and stakeholders due to the very nature of the digitization of education.

CONCLUSION

The work above reflects the experiences and results of using LDB to curb the risks of cheating in OBQs, where OBQs are used to get students to truly engage with disciplinary knowledge and receive validation without using GenAI tools that are readily available through internet-enabled computers. The use of LDB in this context improved monitoring and restricted student activities during OBQs after invigilators were not coping with in-person monitoring. Proving that digital monitoring is essential to maintaining the integrity of LMS-based OBQs as a response to the unwanted use of Gen AI to outsource the assessment task. The advantage of using the in-person LMS-based method is that minimal digital monitoring can be employed, which results in reduced stressors without compromising the integrity of the assessment process. Challenges experienced included the change in access policy by ICT that was not communicated to end-users, thereby affecting the running of the OBQs in LDB in the second semester of 2024.

BIBLIOGRAPHY

Al-Sharbatti, Shatha, Hossam Hamdy, Salah Eldin Kassab, and Manda Venkatramana. "The Effect of Access to Electronic Resources during Examination on Medical and Dental Students Scores in Summative Assessment: Quasi Experimental Study." *BMC Medical Education* 22, no. 1 (December 12, 2022):859.https://doi.org/10.1186/s12909-022-03904-8.

Andreou, Vasiliki, Sanne Peters, Jan Eggermont, Johan Wens, and Birgitte Schoenmakers. "Remote versus On-Site Proctored Exam: Comparing Student Results in a Cross-Sectional Study." *BMC Medical Education* 21, no. 1 (December 20, 2021): 624. https://doi.org/10.1186/s12909-021-03068-x.

Arnold, Ivo J. M. "Online Proctored Assessment during COVID-19: Has Cheating Increased?" *The Journal of Economic Education* 53, no. 4 (October 2, 2022): 277–95. https://doi.org/10.1080/00220485.2022.2111384.

Balash, David G, Dongkun Kim, Darika Shaibekova, Rahel A Fainchtein, Micah Sherr, and Adam J Aviv. "Examining the Examiners: Students' Privacy and Security Perceptions of Online Proctoring Services." In *Seventeenth Symposium on Usable Privacy and Security (SOUPS 2021)*, 633–52, 2021.

Blackie, Margaret, Sioux McKenna, Neil Kramm, and Nicola Pallitt. "Interrogating Assessment in the Age of Generative AI." *African Journal of Inter/Multidisciplinary Studies* 6, no. 1 (2024): 1–11.

Er, Hui Meng, Pei Se Wong, and Vishna Devi Nadarajah. "Remote Online Open Book Examinations: Through the Lenses of Faculty and Students in Health Professions Programmes." *BMC Medical Education* 23, no. 1 (June 2, 2023): 397. https://doi.org/10.1186/s12909-023-04368-0.

Fatima, Syeda Sadia, Romana Idress, Kausar Jabeed, Saniya Sabzwari, and Sadaf Khan. "Online Assessment in Undergraduate Medical Education: Challenges and Solutions from a LMIC University." *Pakistan Journal of Medical Sciences* 37, no. 4 (May 6, 2021). https://doi.org/10.12669/pjms.37.4.3948.

Fendler, Richard, David Beard, and Jonathan Godbey. "A Robust Examination of Cheating on Unproctored Online Exams." *Electronic Journal of E-Learning* 22, no. 5 (May 8, 2024): 26–38. https://doi.org/10.34190/ejel.22.5.3173.

Kurniawan, Oka, Norman Tiong Seng Lee, and Christopher M. Poskitt. "Securing Bring-Your-Own-Device (BYOD) Programming Exams." In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*, 880–86. New York, NY, USA: ACM, 2020. https://doi.org/10.1145/3328778.3366907.

Markus, Elisha D, and Ntombizanele Maqache. "Advancing Students Learning Experiences in Laboratory Reporting through the Use of a Course Management System." In *Academic Conferences and Publishing Limited (July 2018)*, 2018.

Ng, Curtise Kin Cheung. "Evaluation of Academic Integrity of Online Open Book Assessments Implemented in an Undergraduate Medical Radiation Science Course during COVID-19 Pandemic." *Journal of Medical Imaging and Radiation Sciences* 51, no. 4 (December 2020): 610–16. https://doi.org/10.1016/j.jmir.2020.09.009.

Ní Fhloinn, Eabhnat, and Olivia Fitzmaurice. "The Impact of the COVID-19 Pandemic upon Mathematics Assessment in Higher Education." *Education Sciences* 15, no. 4 (April 3, 2025): 449. https://doi.org/10.3390/educsci15040449.

Novick, Peter A., Jacqueline Lee, Sujun Wei, Emily C. Mundorff, Jessica R. Santangelo, and Timothy M. Sonbuchner. "Maximizing Academic Integrity While Minimizing Stress in the Virtual Classroom." *Journal of Microbiology & Biology Education* 23, no. 1 (April 29, 2022). https://doi.org/10.1128/jmbe.00292-21.

Raghavan, Vijay, and Xiaoni Zhang. "Effectiveness of Digital Controls in Stopping Academic Dishonesty in Remotely Administered Tests," 2017.

Rodríguez-Villalobos, Martha, Jessica Fernandez-Garza, and Yolanda Heredia-Escorza. "Monitoring Methods and Student Performance in Distance Education Exams." *The International Journal of Information and Learning Technology* 40, no. 2 (March 17, 2023): 164–76. https://doi.org/10.1108/IJILT-04-2022-0085.

Tian, Tian, Ronald F. DeMara, and Su Gao. "Efficacy and Perceptions of Assessment Digitization within a Large-enrollment Mechanical and Aerospace Engineering Course." *Computer Applications in Engineering Education* 27, no. 2 (March 3, 2019): 419–29. https://doi.org/10.1002/cae.22086.

Vazquez, Jose J., Eric P. Chiang, and Ignacio Sarmiento-Barbieri. "Can We Stay One Step Ahead of Cheaters? A Field Experiment in Proctoring Online Open Book Exams." *Journal of Behavioral and Experimental Economics* 90 (February 2021): 101653. https://doi.org/10.1016/j.socec.2020.101653.

Zagury-Orly, Ivry, and Steven J. Durning. "Assessing Open-Book Examination in Medical Education: The Time Is Now." *Medical Teacher* 43, no. 8 (August 3, 2021): 972–73. https://doi.org/10.1080/0142159X.2020.1811214.

ABOUT AUTHOR

Ntombizanele (Zanele) Maqache is a lecturer in the Department of Electrical, Electronic and Computer Engineering at the Central University of Technology, Free State, where she teaches and conducts research in renewable energy systems, the Internet of Things, and engineering education. She holds a Master of Engineering degree from CUT, and she has published in international journals and conferences on both solar energy applications and innovative approaches to laboratory reporting in engineering education. She is also an NRF Thuthuka grant holder and an active contributor to student learning and outreach initiatives.